

CLAIMS

What is claimed is:

- 1 1. A method of characterizing an environment, comprising:
 - 2 receiving uplink signals from a plurality of antenna array elements;
 - 3 estimating uplink spatial signatures from the received uplink signals; and
 - 4 characterizing the environment based on the estimated uplink spatial
- 5 signatures.

- 1 2. The method of claim 1 wherein estimating uplink spatial signatures
- 2 comprises:
 - 3 estimating an uplink spatial signature of the received uplink signals; and
 - 4 calculating a geometric uplink spatial signature of the received uplink
 - 5 signals.

- 1 3. The method of claim 2 wherein characterizing the environment based
- 2 on the estimated uplink spatial signatures comprises:
 - 3 finding a correlation between the estimated uplink spatial signature and
 - 4 the geometric uplink spatial signature; and
 - 5 selecting a low clutter environment estimation if the correlation between
 - 6 the estimated uplink spatial signature and the geometric uplink spatial signature is
 - 7 greater than a low clutter threshold.

1 4. The method of claim 2 wherein calculating the geometric uplink spatial
2 signature comprises:

3 estimating a dominant angle of arrival of the uplink signals received by the
4 plurality of antenna array elements;

5 calculating an uplink spatial signature of the received uplink signals using
6 the estimated dominant angle of arrival.

1 5. The method of claim 2 wherein finding the correlation between the
2 estimated uplink spatial signature and the geometric uplink spatial signature
3 comprises calculating a normalized dot product of the estimated uplink spatial
4 signature and the geometric uplink spatial signature.

1 6. The method of claim 2 wherein estimating the uplink spatial signature
2 of the received uplink signals comprises calculating a correlation vector between
3 the uplink signals received by the plurality of antenna array elements and a
4 reference signal.

1 7. A method of characterizing an environment, comprising:
2 receiving uplink signals from a plurality of antenna array elements;
3 calculating pairwise correlations of the uplink signals received by the
4 plurality of antenna array elements;
5 calculating an average of absolute values of said pairwise correlations of
6 the uplink signals received by the plurality of antenna array elements; and

7 selecting a high clutter environment estimation if the average of the
8 absolute values of said pairwise correlations of the uplink signals received by the
9 plurality of antenna array elements is less than a high clutter threshold.

1 8. The method of claim 7 wherein calculating said pairwise correlations of
2 the uplink signals received by the plurality of antenna array elements comprises
3 calculating a normalized dot product for said pairwise correlations of the uplink
4 signals received by the plurality of antenna array elements.

1 ~~9.~~ A method of characterizing an environment, comprising:
2 receiving uplink signals from a plurality of antenna array elements;
3 calculating a correlation matrix from the uplink signals received by the
4 plurality of antenna array elements;
5 estimating a source order from the correlation matrix; and
6 selecting a high interference environment estimation if the estimated
7 source order is greater than a high interference threshold.

1 10. The method of claim 9 wherein estimating the source order in
2 response to the correlation matrix comprises:
3 calculating Eigen values of the correlation matrix; and
4 performing a sequential hypothesis technique on the Eigen values to
5 estimate the source order.

1 11. The method of claim 9 wherein estimating the source order in
2 response to the correlation matrix comprises:
3 calculating Eigen values of the correlation matrix; and
4 performing an Akaike Information Criteria technique on the Eigen values
5 to estimate the source order.

1 12. The method of claim 9 wherein estimating the source order in
2 response to the correlation matrix comprises:
3 calculating Eigen values of the correlation matrix; and
4 performing a minimum descriptive length technique on the Eigen values to
5 estimate the source order.

1 13. A method of characterizing an environment, comprising:
2 receiving uplink signals from a plurality of antenna array elements;
3 calculating a signal to noise ratio in response to the uplink signals received
4 from the plurality of antenna array elements;
5 measuring a bit error rate (BER) in response the uplink signals received
6 from the plurality of antenna array elements;
7 determining an expected BER in response to the signal to noise ratio; and
8 selecting a high interference environment estimation if the measured BER
9 is a BER threshold amount greater than the expected BER.

1 14. The method of claim 13 wherein calculating the signal to noise ratio
2 in response to the uplink signals received from the plurality of antenna array
3 elements comprises:

4 measuring a received signal strength indication (RSSI) in response to the
5 uplink signals received from the plurality of antenna array elements; and
6 measuring noise included in the uplink signals received from the plurality
7 of antenna array elements.

1 15. The method of claim 14 further comprising selecting the high
2 interference environment estimation if the measured BER is a BER threshold
3 amount greater than the expected BER and the RSSI is greater than a RSSI
4 threshold value.

1 16. An apparatus, comprising:
2 a plurality of antenna elements;
3 a receiver coupled to receive uplink signals from the plurality of antenna
4 elements; and
5 a signal processor coupled to receive the uplink signals to select an
6 estimation of an environment responsive to the uplink signals received from the
7 plurality of antenna elements.

1 17. The apparatus of claim 16 further comprising a memory coupled to
2 the receive and the signal processor to store uplink signals received from the
3 plurality of antenna elements.

1 18. The apparatus of claim 16 wherein the signal processor is coupled to
2 select a low clutter environment estimation if a correlation between an estimated
3 uplink spatial signature and a geometric uplink spatial signature is greater than a
4 low clutter estimation threshold.

1 19. The apparatus of claim 18 wherein the signal processor is coupled to
2 calculate the geometric uplink spatial signature responsive to a dominant angle of
3 arrival estimated by the signal processor responsive to the uplink signals received
4 from the plurality of antenna elements.

1 20. The apparatus of claim 16 wherein the signal processor is coupled to
2 select a high clutter environment estimation if an average of absolute values of
3 pairwise correlations of the uplink signals received from the plurality of antenna
4 elements is less than a high clutter estimation threshold.

1 21. The apparatus of claim 20 wherein the signal processor is coupled to
2 calculate said pairwise correlations of the uplink signals received from the
3 plurality of antenna elements by calculating normalized dot products for pairs of
4 the antenna elements.

1 22. The apparatus of claim 16 wherein the signal processor is coupled to
2 select a high interference environment estimation if an estimated source order
3 responsive to the uplink signals received from the plurality of antenna elements is
4 greater than a high interference estimation threshold.

1 23. The apparatus of claim 16 wherein the signal processor is coupled to
2 select a high interference environment estimation if a measured bit error rate
3 (BER) in the uplink signals received from the plurality of antenna elements is
4 greater than an expected BER and a received signal strength indication (RSSI) of
5 the uplink signals is greater than an RSSI threshold value.

1 24. The apparatus of claim 23 wherein the signal processor is coupled to
2 determine the expected BER in response to a signal to noise ratio of the uplink
3 signals received from the plurality of antenna elements.

1 25. A machine-readable medium having stored thereon instructions,
2 which when executed cause:
3 receiving uplink signals from a plurality of antenna array elements;
4 storing the uplink signals received from the plurality of antenna array
5 elements;
6 selecting an estimation of an environment responsive to the uplink signals
7 received from the plurality of antenna elements.

1 26. The machine-readable medium of claim 25 wherein selecting the
2 estimation of the environment comprises:
3 estimating an uplink spatial signature responsive to the uplink signals
4 received from the plurality of antenna array elements;
5 estimating a dominant angle of arrival responsive to the uplink signals
6 received from the plurality of antenna array elements;
7 calculating a geometric uplink spatial signature responsive to the uplink
8 signals received from the plurality of antenna array elements and the estimated
9 dominant angle of arrival;
10 finding a correlation between the estimated uplink spatial signature and
11 the geometric spatial signature; and
12 selecting a low clutter environment estimation if the correlation between
13 the estimated uplink spatial signature and the geometric spatial signature is greater
14 than a low clutter threshold.

1 27. The machine-readable medium of claim 26 wherein finding the
2 correlation between the estimated uplink spatial signature and the geometric
3 spatial signature comprises calculating a normalized dot product between the
4 estimated uplink spatial signature and the geometric spatial signature.

1 28. The machine-readable medium of claim 25 wherein selecting the
2 estimation of the environment comprises:

3 calculating pairwise correlations of the uplink signals received from the
4 plurality of antenna array elements;
5 calculating an average of absolute values of said pairwise correlations of
6 the uplink signals received by the plurality of antenna array elements; and
7 selecting a high clutter environment estimation if the average of the
8 absolute values of said pairwise correlations of the uplink signals received by the
9 plurality of antenna array elements is less than a high clutter threshold.

1 29. The machine-readable medium of claim 28 wherein calculating
2 pairwise correlations of the uplink signals received from the plurality of antenna
3 array elements comprises calculating a normalized dot product for said pairwise
4 correlations of the uplink signals received from the plurality of antenna array
5 elements.

1 30. The machine-readable medium of claim 25 wherein selecting the
2 estimation of the environment comprises:
3 calculating a correlation matrix in response to the uplink signals received
4 from the plurality of antenna array elements;
5 estimating a source order in response to the correlation matrix; and
6 selecting a high interference environment estimation if the source order is
7 greater than a high interference threshold.

1 31. The machine-readable medium of claim 30 wherein estimating the
2 source order in response to the correlation matrix comprises calculating Eigen
3 values of the correlation matrix and estimating the source order in response to the
4 calculated Eigen values.

1 32. The machine-readable medium of claim 25 wherein selecting the
2 estimation of the environment comprises:
3 measuring a bit error rate (BER) in response to the uplink signals received
4 from the plurality of antenna array elements;
5 determining an expected BER in response to the uplink signals received
6 from the plurality of antenna array elements;
7 selecting a high interference environment estimation if the measured BER
8 is a BER threshold amount greater than the expected BER and a received signal
9 strength indication (RSSI) of the uplink signals is greater than an RSSI threshold
10 value.

1 33. The machine-readable medium of claim 32 wherein determining an
2 expected BER in response to the uplink signals received from the plurality of
3 antenna array elements comprises measuring a signal to noise ratio of the uplink
4 signals received from the plurality of antenna array elements, the expected BER
5 related to the signal to noise ratio.

1 34. A method of characterizing an environment, comprising:

2 receiving uplink signals from a plurality of antenna array elements; and
3 characterizing the environment based on the received uplink signals.

1 35. The method of claim 34 wherein characterizing the environment based
2 on the received uplink signals comprises:

3 estimating an uplink spatial signature from the received uplink signals;
4 calculating a geometric uplink spatial signature from the received uplink
5 signals;

6 finding a correlation between the estimated uplink spatial signature and
7 the geometric uplink spatial signature; and
8 selecting a low clutter environment if the correlation between the
9 estimated uplink spatial signature and the geometric uplink spatial signature is
10 greater than a low clutter threshold.

1 36. The method of claim 34 wherein characterizing the environment based
2 on the received uplink signals comprises:

3 calculating pairwise correlations of the uplink signals;
4 calculating an average of absolute values of said pairwise correlations; and
5 selecting a high clutter environment estimation if the average of the
6 absolute values of said pairwise correlations is less than a high clutter threshold.

1 37. The method of claim 34 wherein characterizing the environment based
2 on the received uplink signals comprises:

3 calculating a correlation matrix from the uplink signals;
4 estimating a source order from the correlation matrix; and
5 selecting a high interference environment estimation if the estimated
6 source order is greater than a high interference threshold.

1 38. The method of claim 34 wherein characterizing the environment based
2 on the received uplink signals comprises:

3 calculating a signal to noise ratio in response to the uplink signals;
4 measuring a bit error rate (BER) in response to the uplink signals;
5 determining an expected BER in response to the signal to noise ratio; and
6 selecting a high interference environment estimation if the measured BER
7 is a BER threshold amount greater than the expected BER and a received signal
8 strength indication (RSSI) of the uplink signals is greater than an RSSI threshold
9 value.

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